A Three-Dimensional Representation of Measurement Data

BY

PAUL CHANLEY

AND

W. A. VAN ENGEL

Virginia Institute of Marine Science, Gloucester Point, Virginia 23062 [1]

(4 Text figures)

IT HAS BEEN FOUND convenient in describing bivalve larvae to present length, height and depth relationships in a three-dimensional graph (CHANLEY, 1969). Such a graph may also be used to illustrate other kinds of measurement data. Dimensions of the larvae of a small commensal bivalve, *Montacuta percompressa* DALL, 1899, have been plotted to illustrate the construction and interpretation of the graph.

The vertical axis represents height and the horizontal axis depth (Figure 1). The axis at 45° between these two represents length. The vertical plane formed from the height axis along the length axis and the horizontal plane formed from the depth axis along the length axis provide surfaces on which two-dimensional representations of the height : length and length : depth relationships can be plotted. Height and depth coordinates extend from their respective axes parallel to both the height and depth axes and form right angles at the length axis. The line AB represents a height of 169μ; EH a depth of 77μ; and IJL a length of 200μ. Length 200μ by height 169μ is marked where lines AB and IJ intersect, length 200μ by depth 77μ where lines EH and IL intersect. Measurements of larval *Montacuta percompressa* have been plotted on the appropriate planes as dots which have been enclosed with lines by inspection. Line MN represents minimum depth, OP maximum depth, QR minimum height, and ST maximum height for any length.

A three-dimensional concept of the length:height:depth relationship can now be advanced by considering each measurement a plane. For example, height 169μ that was represented as line AB in Figure 1 may also be represented as plane ABCD in Figure 2. Similarly lines EH and IJL can be represented as planes EFGH and IJKL, respectively. The broken lines indicate the intersections of these planes; length 200μ by height 169μ by depth 77μ is the point W, located at the intersection of all three planes.

Point W is one vertex of a base plane that defines the limits of height and depth for a length of 200μ. The other vertices of the base plane can be obtained (1) by finding the points where the length plane for 200μ (IJKL) intersects lines MN, OP, QR, and ST (Figure 3), and (2) extending horizontal and vertical lines (broken) from these points to new points of intersection W, X, Y and Z. Thus, at length 200μ, point W represents the minimum height and depth, X maximum height and minimum depth, Y maximum height and depth, and Z minimum height and maximum depth. Lines WX and YZ equal the range in height for length 200μ, while lines WZ and XY equal the range in depth. Base plane WXYZ encompasses all possible combinations of height and depth for a length of 200μ.

Similar base planes may be constructed at selected lengths (as shown for 250μ in Figure 3) over the entire length range. When the vertices of all base planes are connected by lines, the resulting three-dimensional figure (Figure 4) encompasses all possible length:height:depth combinations. This figure is a polyhedron consisting of a series of rectangular oblique prisms whose bases are parallel planes.

If the polyhedron overlaps the length axis or is otherwise poorly placed, it can be raised or lowered by adding or subtracting units at the base of the height axis. It can be moved laterally or backward and forward by similar manipulation of the depth and length axes.

Construction of a polyhedron is a relatively easy method of reducing a series of 3 continuous variables to a simpler form. Because the data are not reduced to statistics to which tests of significance can be applied,

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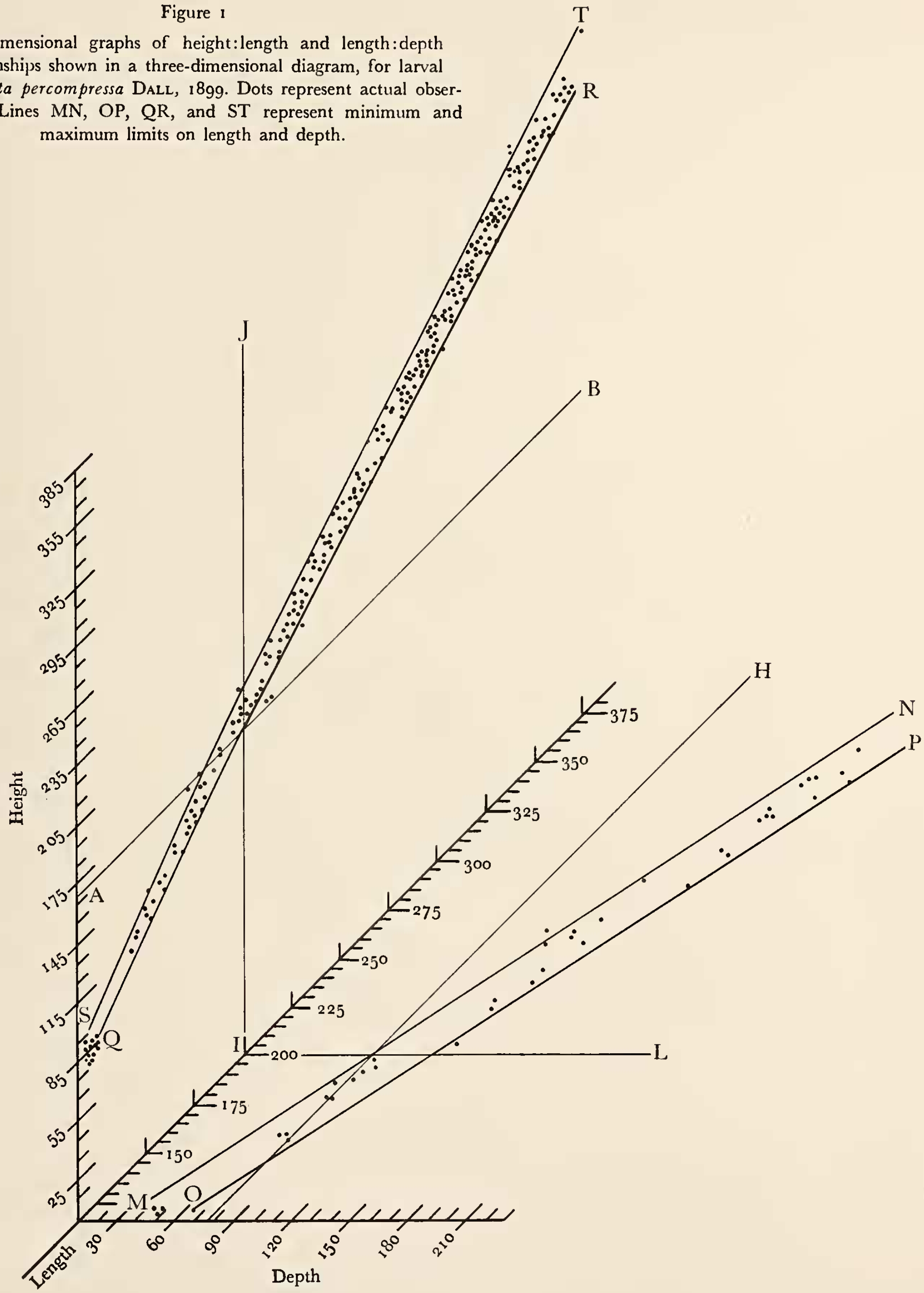
Figure 1

Two-dimensional graphs of height:length and length:depth relationships shown in a three-dimensional diagram, for larval *Montacuta percompressa* Dall, 1899. Dots represent actual observations. Lines MN, OP, QR, and ST represent minimum and maximum limits on length and depth.



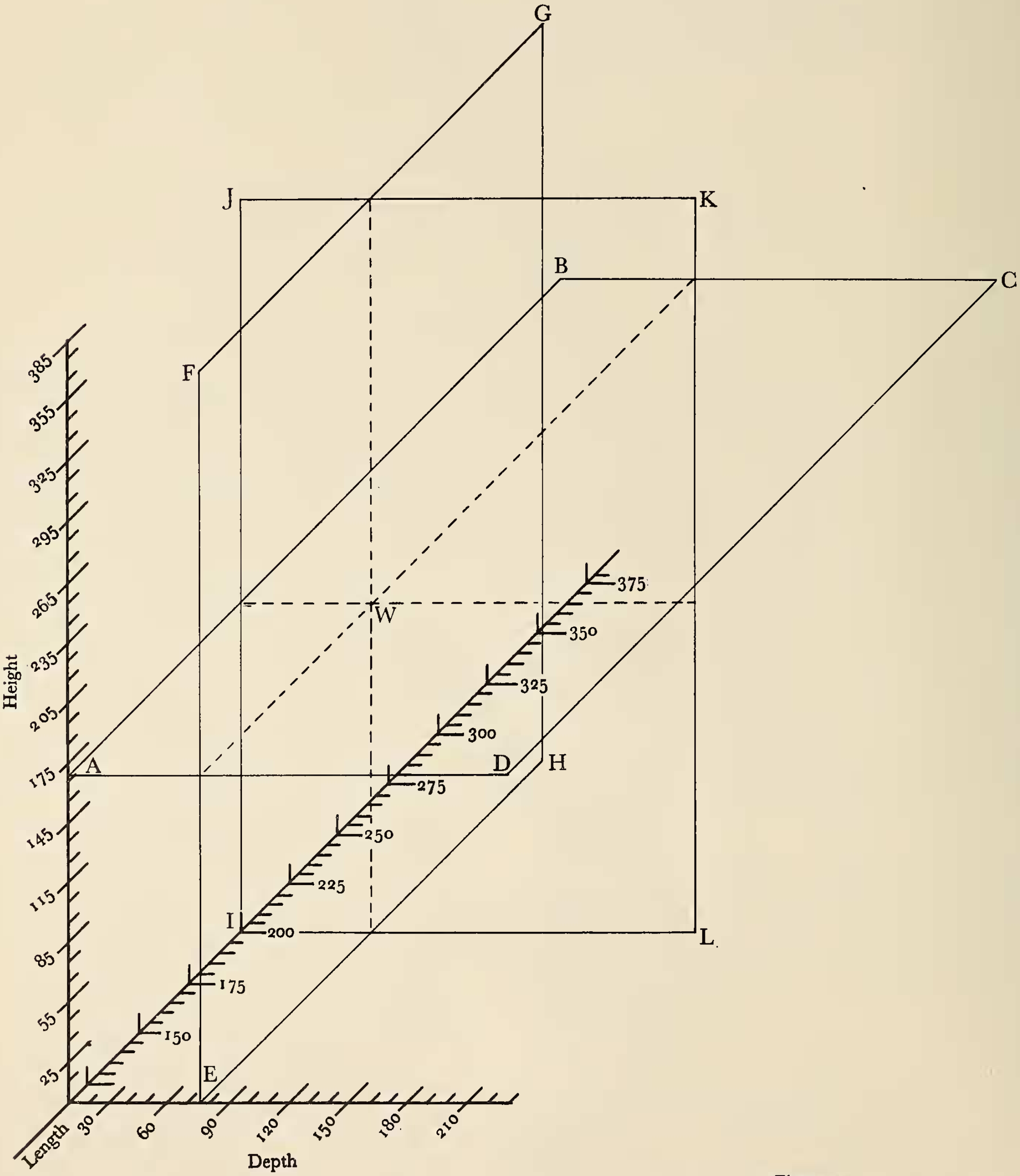


Figure 2

Three-dimensional diagram of plane surfaces representing height at 169 μ, depth at 77 μ, and length at 200 μ. Broken lines represent the intersection of pairs of planes. W is the point of intersection of all three planes.

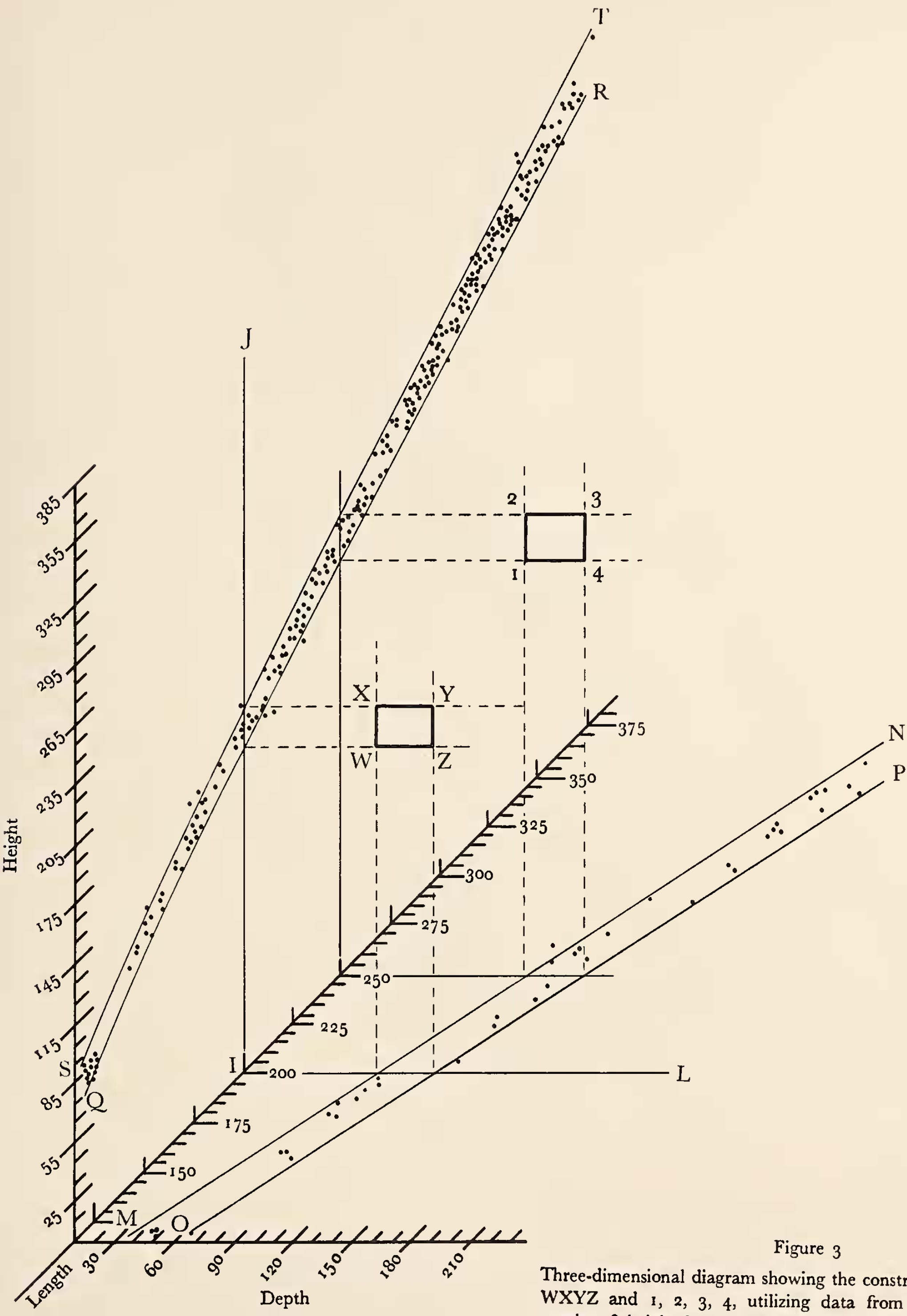


Figure 3

Three-dimensional diagram showing the construction of base planes WXYZ and 1, 2, 3, 4, utilizing data from the two-dimensional graphs of height: length and length: depth. WXYZ and 1, 2, 3, 4 encompass all height and depth combinations for lengths of 200 μ and 250 μ, respectively.

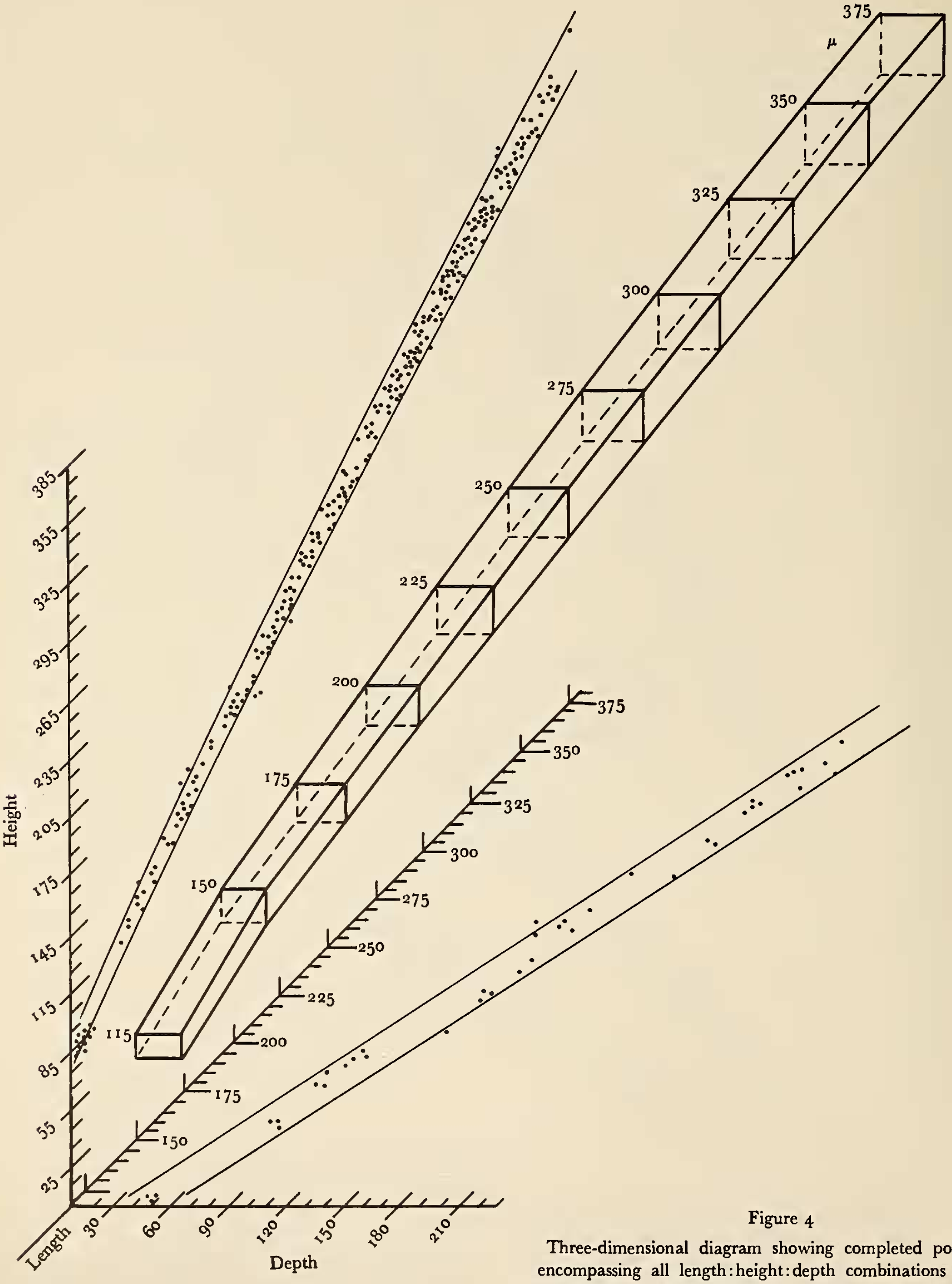


Figure 4

Three-dimensional diagram showing completed polyhedron encompassing all length:height:depth combinations of larval *Montacuta percompressa* and two-dimensional graphs of height: length and length:depth. Base planes are shown for length 115 µ and at 25 µ intervals of length from 150 µ to 375 µ.

comparisons with other sets of measurements are limited. An alternative method, multiple regression analysis, would provide a meaningful statistical statement, but could not be used if the variates do not follow a multivariate normal distribution where linearity of regression is requisite.

Each set of measurement data for any species of bivalve larvae may have a characteristic polyhedron graphically distinguishable from other polyhedra. Similarly, averages and ranges may be peculiar to each set. If polyhedrons are determined for a sufficient number of species computer identification of planktonic larvae may be possible.

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LITERATURE CITED

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